PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:
TAKAGUCHI et al
Application No.: 10/573,449 Art Unit: 1793
Filing date: January 19, 2007 Examiner: Megha Mehta
For: WAVE SOLDERING TANK

DECLARATION UNDER 37 CFR 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, Hirokazu Ichikawa, declare as follows:

I am currently the head of the FA Manufacturing Department at the Technical Center of Senju Metal Industry Co., Ltd. (Senju Metal) in Tokyo, Japan. I have been employed by Senju Metal, which is the assignee of this application, since 1990. My primary work is the design and development of automatic soldering equipment.

In 2005, I performed a number of experiments to compare the performance of different screw pumps in a wave soldering tank. The experiments were performed at the Technical Center in Tokyo.

The experiments were performed using a Model EWD-30 wave soldering tank manufactured by Senju Metal Industry Co., Ltd. The soldering tank contained 400 kg of a Sn-3Ag-0.5Cu lead-free solder maintained at 25 degrees C. The tank included a primary nozzle and a secondary nozzle which were supplied with molten solder by a screw pump having either a single helical blade, two helical blades, or four helical blades. I will refer to these a 1-blade pump, a 2-blade pump, or a 4-blade pump.

In a first experiment, the pump was operated at different rotational speeds, and the height of the solder wave discharged from the secondary nozzle was measured with a commercially-available laser displacement sensor. At each rotational speed, the solder wave was allowed to stabilize before measurement of the height took place. Therefore, the measured height indicated a steady-state value. Attached Exhibit A shows the height measurements for the 2-blade pump and the 4-blade pump.

Exhibit A shows that at a given rotational speed, the 4-blade pump tended to produce a greater wave height than the 2-blade pump. However, the difference in the wave height diminished towards zero as the rotational speed increased.

A second experiment was similar to the first experiment in that a pump was operated a different rotational speeds, and the height of the solder wave discharged from the secondary nozzle was again measured with a laser displacement sensor. The rotational

speed was changed instantaneously in increments of 5 Hz. However, in the second experiment, the wave height was measured continuously from before to after a change in rotational speed to observe the transient characteristics of the wave. In particular, I was interested in the length of time required for the wave height to stabilize at a new height after a change in rotational speed.

Attached Exhibit B shows the results for a 1-blade pump (page 1) and a 4-blade pump (page 2). Similar to the results shown in Exhibit A, Exhibit B shows that at each rotational speed, the 4-blade pump produced a greater wave height than the 1-blade pump. More importantly, Exhibit B shows that when a step change in pump rotational speed took place, the height of the solder wave stabilized much more rapidly for the 4-blade pump than for the 1-blade pump. The difference in the length of time required for stabilization became increasingly marked as the rotational speeds of the pumps increased.

The significance of this difference is as follows. One method of wave soldering involves repeatedly varying the wave height of solder discharged from the nozzles of a wave soldering tank. When an electronic part such as a printed circuit board is remote from the nozzles, the pump of the wave soldering tank is operated at a low rotational speed, and the wave height of the waves discharged from the nozzles is set to a very low level in order to reduce oxidation of molten solder in the wave soldering tank. When an electronic part to be soldered approaches the nozzles, the pump

rotational speed is abruptly increased, and the wave height is increased to a level suitable for soldering. After the electronic part has passed through the solder waves, the pump rotational speed is decreased again and the wave height is returned to the very low level. Each time the pump rotational speed is increased in a step-wise manner, it takes a certain length of time for the wave height to stabilize at a new level. An electronic part should not be passed through a solder wave when the wave height is greatly fluctuating because the amount of solder which contacts the electronic part will not be predictable. Therefore, it is necessary to slow down the speed of a conveyor for the electronic part until the wave height has stabilized.

The more quickly the wave height can stabilize, the more quickly can the conveyor operate, and the more electronic parts can be passed through a solder wave per minute. Page 1 of Exhibit B shows that in the case of the 1-blade pump, it sometimes took as long as 30 seconds for the wave height to stabilize in response to a 5Hz change in pump rotational speed. In contrast, page 2 of Exhibit B shows that in the case of the 4-blade pump, the wave height stabilized almost immediately. Therefore, the use of 4-blade screw pump in a wave soldering tank can provide a much high throughput of electronic parts than can the use of a 1-blade screw pump.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements

were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Respectfully submitted,

Hirokazu Ichikawa

Hirokazu Ichikawa

Tokyo, Japan

Date: Feb. 22. 2011

Attachments
Exhibit A
Exhibit B

Exhibit A

Comparison of 4-blade pump and 2-blade pump

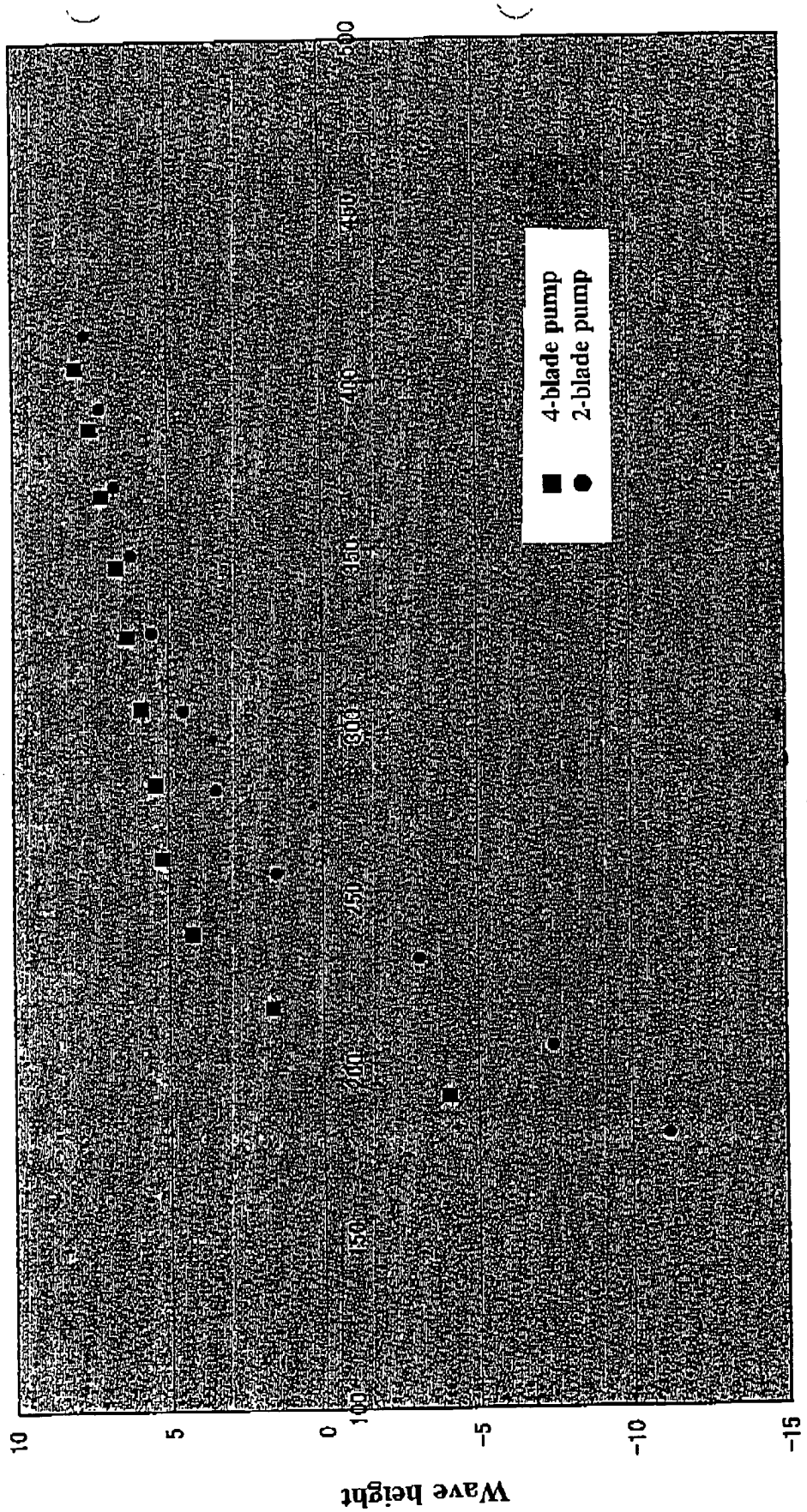

Exhibit B, page 1 1-blade spiral screw

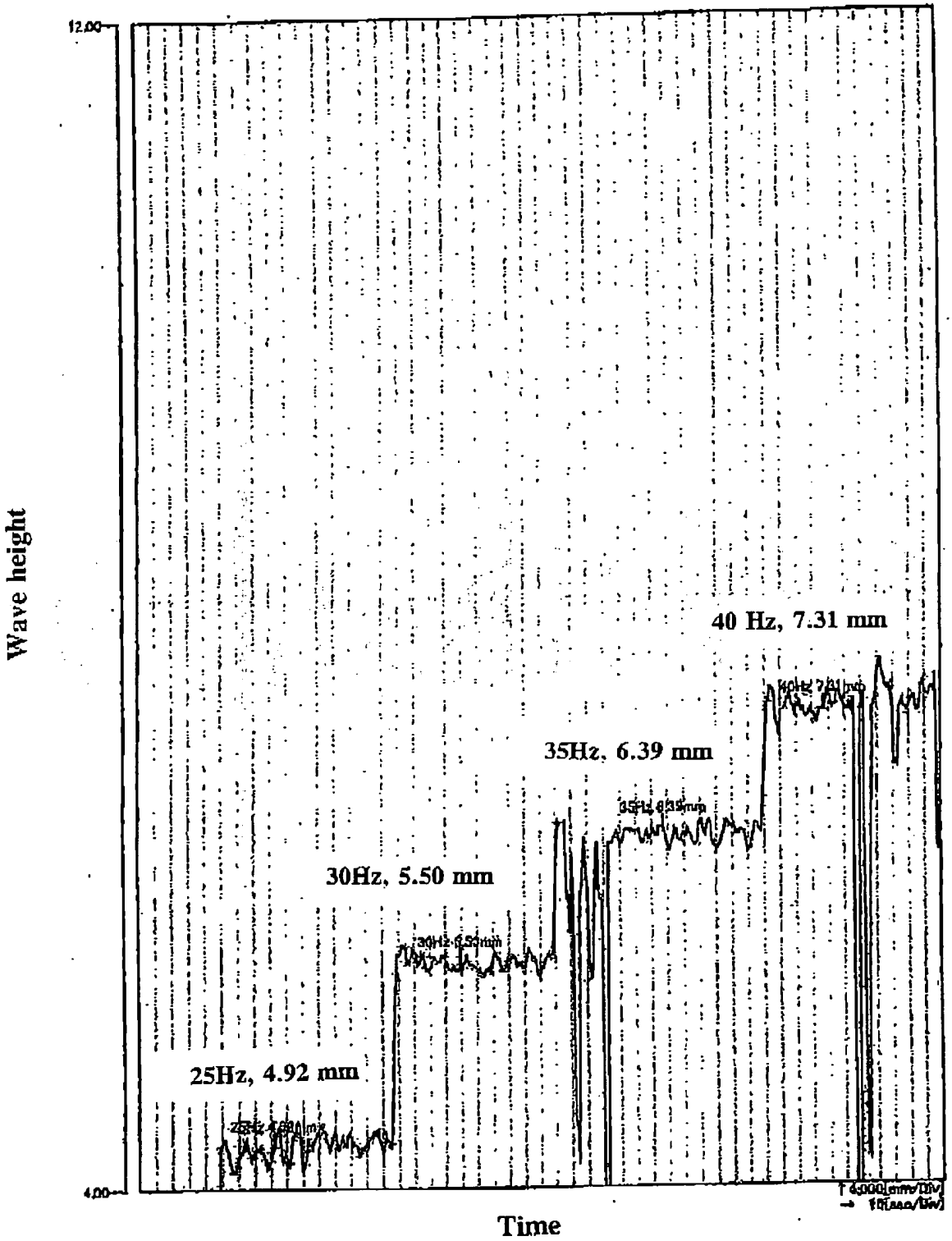

Exhibit B, page 2 4-blade spiral screw